

UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: ENERGY CONSERVATION



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U.S. ARMY CORPS OF ENGINEERS (Preparing Activity)

NAVAL FACILITIES ENGINEERING COMMAND

AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

Record of Changes (changes are indicated by \1\ ... /1/)

Change No.	Date	Location

This UFC supersedes Military Handbook 1190, dated 1 September 1987, Chapter 8, and TI 800-01, dated 20 July 1998, Chapter 11.

FOREWORD

The Unified Facilities Criteria (UFC) system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with [USD\(AT&L\) Memorandum](#) dated 29 May 2002. UFC will be used for all DoD projects and work for other customers where appropriate.

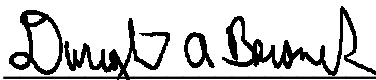
UFC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and Air Force Civil Engineer Support Agency (AFCESA) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content of UFC is the responsibility of the cognizant DoD working group. Recommended changes with supporting rationale should be sent to the respective service proponent office by the following electronic form: [Criteria Change Request \(CCR\)](#). The form is also accessible from the Internet sites listed below.

UFC are effective upon issuance and are distributed only in electronic media from the following sources:

- Unified Facilities Criteria (UFC) Index http://65.204.17.188//report/doc_ufc.html.
- USACE TECHINFO Internet site <http://www.hnd.usace.army.mil/techinfo/index.htm>.
- NAVFAC Engineering Innovation and Criteria Office Internet site <http://criteria.navfac.navy.mil>.
- Construction Criteria Base (CCB) system maintained by the National Institute of Building Sciences at Internet site <http://www.nibs.org/ccb>.

Hard copies of UFC printed from electronic media should be checked against the current electronic version prior to use to ensure that they are current.

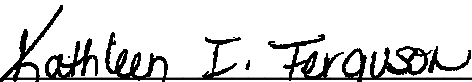
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DESIGN: ENERGY CONSERVATION

1-0 INTRODUCTION

1-1 **PURPOSE.** This document establishes minimum standards and policy for energy and water conservation in new construction and renovation of existing facilities. Federal facilities are required to comply with various Executive Orders and Congressional actions regarding energy and water use, conservation and efficiency standards. In addition, the services have other unique requirements to ensure the planning, programming, design and construction of energy efficient, life-cycle cost effective facilities that meet the mission requirements and needs of the services. These requirements are an integral part of the criteria and standards used by each of the services. Full compliance with this and other DoD Unified Facility Criteria documents and Unified Facility Guide Specifications, along with any service unique criteria and guidance, will ensure that facilities are planned, designed and constructed in accordance with Federal Regulations, Executive Orders, Congressional actions and similar mandates.

1-2 **SCOPE.** This UFC applies to new construction and to both major and minor facility renovations.

1-2.1 **Major Renovation.** Building modifications should be classified as a major renovation if the overall features of the building's envelope will be substantially altered or if the changes include substantial replacement of the building's lighting, plumbing, electrical, and heating, ventilating, and air conditioning (HVAC) systems in combination with other significant alterations of the building's spaces. Other modifications to a building may be categorized as a major renovation depending on the overall magnitude and scope of the work to be accomplished. Buildings classified as major renovation projects will comply with all energy and water conservation methods and standards, to the extent life cycle cost effective and technically feasible for the application at hand. All building components and systems being renovated or replaced must comply with their respective energy and water conservation criteria. Major upgrades to "new building" energy and water conservation levels should be planned for funding as early as possible on DD Form 1391. Funding requirements to implement energy and water conservation measures will be an integral part of the concept design.

1-2.2. **Minor Modifications and Renovations.** Repair and/or replacement of windows, doors, lighting fixtures, HVAC equipment, and similar type modifications to existing buildings will be classified as minor repairs or modifications. Other changes to an existing building, requiring modifications to one or several sections only, should be classified as a minor renovation. The classification of a building modification into a minor or major renovation category depends on the overall magnitude and scope of work to be accomplished. Minor repairs, modifications, and renovations will comply with applicable energy and water conservation criteria to the extent of the item or system to

be replaced. Other portions of the existing system(s) or building not affected by the repairs or modifications will not be replaced solely to comply with "new building" energy and water conservation standards.

1-2.3. **Interpretation of Terms.** Interpret the terms used in ASHRAE Standard 90.1 as follows:

Authority Having Jurisdiction (AHJ): The Contracting Officer or designated representative.

Building Official: The Contracting Officer's Representative.

Owner: The Government

Permit Holder: The Contractor

1-3 **REFERENCES.**

ASHRAE Standard 90.1 – 2001, Energy Standard for Buildings Except Low-Rise Residential Buildings, American Society of Heating Refrigeration and Air Conditioning Engineers, Inc., Atlanta Georgia

Executive Order 13123, Greening the Government Through Efficient Energy Management, June 3, 1999

UFC 3-400-02, Engineering Weather Data (to be published)

ASHRAE Handbook of Fundamentals – 2001, American Society of Heating Refrigeration and Air Conditioning Engineers, Inc., Atlanta Georgia

Title 10 Code of Federal Regulations, Part 436 – Federal Energy Management and Planning Programs, Subpart A – Methodology and Procedures for Life Cycle Cost Analysis

ASHRAE Standard 90.1 – 1999, Energy Standard for Buildings Except Low-Rise Residential Buildings, User's Manual, American Society of Heating Refrigeration and Air Conditioning Engineers, Inc., Atlanta Georgia

2-0 **GENERAL REQUIREMENTS.**

2-1 **MANDATORY ENERGY AND WATER CONSERVATION CRITERIA.** Family housing (residential) shall be designed and constructed in accordance with the latest Energy Star standards, per other appropriate service-specific criteria and guidance. Other facilities shall be designed and constructed in accordance with the latest edition of ASHRAE Standard 90.1. The Simplified Approach Option for HVAC Systems may be used where the specific system and facility design meets all of the relevant ASHRAE Standard 90.1 criteria. Although the Mandatory Provisions with the Prescriptive Path

may be used for any applicable facility, the use of the Mandatory Provisions with the Energy Cost Budget Method should be considered for large or complex facilities where there is a significant potential for trade offs between systems and system components and large energy and life cycle cost savings. In accordance with Executive Order 13123, appliances, HVAC equipment and other energy consuming equipment shall have an energy efficiency rating in the upper 25 percent of that available as long as these efficiency requirements are nonproprietary and life cycle cost effective. In general, the Department of Energy and Federal Energy Management Program recommendations from the Buying Energy Efficient Products Guide and the Environmental Protection Agency Energy Star products program meet these requirements. The DOE recommendations are available on the web at www.eren.doe.gov/femp/procurement.

2-2 SUSTAINABLE DESIGN AND DEVELOPMENT. In accordance with Executive Order 13123, sustainable design shall be an integral part of every project. This requires an integrated and coordinated approach to the planning, design and construction of facilities and extensive use of environmentally preferable products, recovery and recycling of materials and waste reduction as well as an emphasis on the long-term quality and productivity of the built environment. Energy and water conservation are primary goals of sustainable design and development and are major requirements in complying with Executive Order 13123.

2-3 ENERGY AND WATER CONSERVATION MEASURES. There are numerous energy and water conservation measures that should be considered for any facility. Many are related to the siting and footprint of the facility to take advantage of solar orientations, prevailing winds and natural topography and vegetation. Some passive solar features are applicable to most buildings and active solar systems for domestic water heating and preheating are becoming cost effective in some areas, depending on the source and cost of energy. Thermal storage systems may not really reduce the total energy usage but can shift the loads to off peak hours saving significantly in energy cost and greatly improving the demand curve. Other techniques such as micro cogeneration and distributed power generation are beginning to be implemented in the Federal sector and offer great opportunities for large energy and cost savings. Other techniques such as desiccant cooling, enthalpy wheels, radiant heating and heat recovery have a proven record and should be considered for many different applications. Many super low-flow plumbing fixtures are now providing acceptable service, waterless urinals are being successfully used in a number of military applications and water recovery and recycling systems are often cost effective. Xerophytic landscaping and the use of native plants and vegetation can not only reduce first cost and maintenance requirements but also reduce or completely eliminate the need for watering. The extent of energy and water conservation measures and techniques that should be considered during the planning and design process is only limited by the imagination and innovation of the project delivery team. Alternative funding sources such as rebates from the utility companies shall be considered and used where available and appropriate for funding the additional cost of energy and water conservation measures.

2-4 **FUNCTIONAL REQUIREMENTS AND COMFORT.** The mission and function of the facility and the long term comfort, health and productivity of the occupants are critical considerations in the planning, design and construction of any facility. Generally, all practical and life cycle cost effective energy and water conserving features will be included in the planning, design and construction of facilities. However, features that will adversely impact the mission or comfort, health and productivity of the occupants shall not be included. In addition, system selection and incorporation of energy and water conserving features shall be closely coordinated with the facility user and maintenance staff. Only those systems and features that can be effectively operated and maintained will be considered.

2-5 **ENERGY AND ECONOMIC ANALYSIS CALCULATION METHODS.** All analysis shall be performed based on the actual conditions expected over the life of the facility including anticipated occupancies, scheduled hours of operation and process loads. Realistic energy usage and efficiencies, maintenance cost and repairs and renovations shall be included.

2-5.1 **Energy Calculations.** Energy calculations for new conditioned buildings or for comparing alternative building features and energy conservation techniques or equipment will be determined using a professionally recognized and proven computer program or programs that integrate architectural features with air-conditioning, heating, lighting, and other energy producing or consuming systems. These programs will be capable of simulating the features, systems, and thermal loads used in the design. The energy savings and any parasitic energy loads associated with the utilization of recovered energy, solar heat, solar photovoltaic energy and other renewable or waste heat applications shall be included. Using UFC 3-400-02, Engineering Weather Data, or other established and authoritative weather data files, the program will perform 8760 hourly calculations. Programs that "condense" the weather files and number of calculations into several "typical" or average days per month, follow modified bin calculation procedures or other simplified methods described in the Chapter entitled "Energy Estimating and Modeling Methods" of the ASHRAE Handbook of Fundamentals may be used when the features, size or complexity of the building design and alternatives do not demand more sophisticated energy calculations to give accurate results and support design decisions. In addition, the Department of Energy maintains a list of building energy and water conserving tools for design. A number of the programs may be of benefit in performing energy and water conservation calculations, comparing energy and water system alternatives and evaluating specific conservation measures. The web address for additional information is <http://www.energytoolsdirectory.gov/>

2-5.2 **Economic Analysis.** Life cycle costing shall be in accordance with Title 10 Code of Federal Regulations Part 436, Subpart A. The Life Cycle Costing in Design (LCCID) program is in full compliance with these regulations and is periodically updated to include the latest differential escalation rates, energy cost projections and similar economic factors. LCCID is available from the Building Systems Laboratory at the University of Illinois, <http://www.bso.uiuc.edu>, and from the Construction Criteria Base distributed by the National Institute of Building Science. Another life cycle costing

program in full compliance with the Federal Regulation and updated with the latest economic factors is the Building Life Cycle Costing (BLCC) program available from the National Institute of Standards and Technology. The Department of Energy's building energy tools web site has a link to BLCC (under Energy Economics) and it can also be found at <http://www.eren.doe.gov/femp/techassist/softwaretools/softwaretools.html>. The appropriate cost and savings associated with the utilization of recovered energy, solar heat, solar photovoltaic energy and other renewable or waste heat applications shall be included.

2-5.3 Previous Analyses. To the extent applicable to the project under design, previous analyses or generic studies may be used for demonstrating compliance with energy conservation criteria and for selecting among various alternatives and implementing energy and water conserving features. Previous or generic studies may also be updated and revised to reflect the project under design.

2-6 METERS. Utility meters can be a valuable tool in the effective management of energy and water use at both the individual facility and installation level. A utility meter will be furnished at each building, for each utility serving the building (e.g. steam, high temperature hot water, electricity, natural gas, fuel oil, etc.) in the normal units of the utility (i.e. kWh, cf, gallons, etc.), in accordance with the current requirements of the respective military service or DoD component agency. Except for family housing, a water meter should be provided for each facility where potable water demand is estimated to exceed 378 541 L (100,000 gallons) per year. Design and installation of all meters shall be capable of being easily connected to a base wide energy and utility monitoring and control system directly or via the building HVAC control system.

3-0 CONCEPT DESIGN.

3-1 SYSTEM SELECTION. HVAC system selection and energy and water conservation features to be incorporated into the facility design shall be selected from the viable alternatives based on an energy and life cycle cost analysis. Each of the systems, features and components considered during the concept design or to be considered later during the design process shall be identified and discussed as part of the concept design package.

3-2 COMPLIANCE PATH AND PROJECT DOCUMENTATION. In addition to the Mandatory Provisions, the path or method selected to ensure compliance with ASHRAE Standard 90.1 shall be clearly indicated in the concept design. The reasons and effects, on the energy usage and life cycle cost of the completed facility, of selecting the particular compliance path or method shall be presented. The engineering and economic analysis, including computer simulations and program inputs, outputs and assumptions, used to support the HVAC system selection and other concept design decisions shall be fully documented and made a part of the concept design package. The forms from the ASHRAE Standard 90.1 User's Manual may be helpful in developing the project and compliance documentation.

4-0 **FINAL DESIGN.**

4-1 **GENERAL.** The final design shall be a continuation and extension of the approved concept design. The engineering and economic analysis performed as part of the concept design shall be updated as necessary and included as part of the final design package. Each of the systems, features and components considered during the final design shall be identified and the engineering and economic analysis supporting the design decision for implementation or rejection shall be included.

4-2 **ASHRAE STANDARD 90.1 COMPLIANCE.** Full compliance with the Mandatory Provisions and either the Prescriptive Path or the Energy Cost Budget Method shall be clearly demonstrated. Where life cycle cost effective, the Mandatory Provisions of ASHRAE 90.1 and the selected compliance path or method should be exceeded. The engineering and economic analysis supporting the decisions should be included in the final design package. In those rare cases where the Mandatory Provisions of ASHRAE Standard 90.1 and the selected compliance path or method are not cost effective and a more energy intensive system, feature or component will provide a lower life cycle cost, a detailed justification with life cycle cost comparisons, including the assumptions used in the analysis and unusual facility features or operations, shall be included in the final design.

4-2.1 **Mandatory Provisions.** The final design package shall identify each of the required features applicable to the facility and demonstrate compliance. Any deviations shall be clearly identified and the engineering and economic analysis supporting the deviation provided.

4-2.2 **Prescriptive Path.** The Simplified Approach Option for HVAC Systems may be used where the specific system and facility design meets all of the relevant ASHRAE Standard 90.1 criteria. In all other cases the detailed requirements of the Prescriptive Path, as a minimum, shall be carefully followed. The final design package shall identify each of the features applicable to the facility and demonstrate compliance. Any deviations shall be clearly identified and the engineering and economic analysis supporting the deviation provided.

4-2.3 **Energy Cost Budget Method.** The final design shall include a full description of both the prototype or reference building and the proposed design with supporting engineering and economic analyses including the inputs, outputs and assumptions used in the computer simulations and programs.

5-0 **SPECIAL STUDIES.**

5-1 **PHOTOVOLTAIC.** Photovoltaic power generation is most likely to be life cycle cost effective where there is a relatively small power requirement compared to the cost of connecting the load to the existing electrical grid or where the alternative is diesel driven generation or batteries. In these cases a study comparing the "baseline" design with prospective photovoltaic applications will be performed. Such projects

would typically include cathodic protection of pipelines, cathodic protection of bridges and water towers, data links, emergency and rescue communications, lighting, load center power, marking and warning devices, military range monitoring and conditioning equipment, monitoring and sensing devices, navigational aids, perimeter security devices, remote communication sites, remote instrumentation, remote weather stations and transmitters, repeater stations, and water pumping and purification.

5-2 **WIND ENERGY CONVERSION SYSTEM.** The use of wind power should be considered if a preliminary evaluation or past experience indicates that a sufficient mean annual wind exists for the system to economically meet all or a significant fraction of the load demand. The most economical applications of these systems have typically been for small wind turbine generators, with or without storage, at remote sites. However, larger “wind farms” and grid connected systems are becoming cost effective in some areas. System reliability and the critical nature of the load should be major concerns in selecting and implementing a wind energy conversion system. Realistic projections for maintenance and repair requirements can be critical items in the life cycle cost analysis.

5-3 **GEOTHERMAL ENERGY.** The use of geothermal energy should be considered in areas of proven reserves or in areas that have a high potential for geothermal resources.